Superconducting Magnet Division

Magnet Note

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Title: Vacuum impregnation of short sample HTS and Niobium Tin superconductors

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Vacuum impregnation of short sample HTS and Niobium Tin superconductors

Development work is underway utilizing Niobium Tin superconductors within a react and wind, vacuum impregnated coil program. Since the superconductors are tested in magnet form impregnated, a development program is underway to impregnate the cable samples used for the characterization testing of the reacted superconductor, allowing testing to mimic the actual use conditions for the conductors.

Sample design

The short sample test fixturing requires an impregnated sample approximately 48 inches long. The lead end of the sample, being out of the test field, is connected to the dewar tophat using a NbTi Rutherford cable. The typical short sample is composed of two pieces of cable to be tested, assembled together in parallel, with the cables soldered together at the non lead end, the lowest point of the assembly when the sample is hung in the test magnetic field.

Figure 1 Typical short samples

Voltage taps and spot heaters are often included to better characterize the cables. They are added to the sample before it is clamped into the test fixture.

To prevent movement during test, the samples are assembled in a clamping fixture, and suspended in a test magnet. The fixture is required to limit conductor movement as a result of the forces on the conductors from the currents within, both forces from within the cables, and forces resulting from the magnetic field the sample is in.

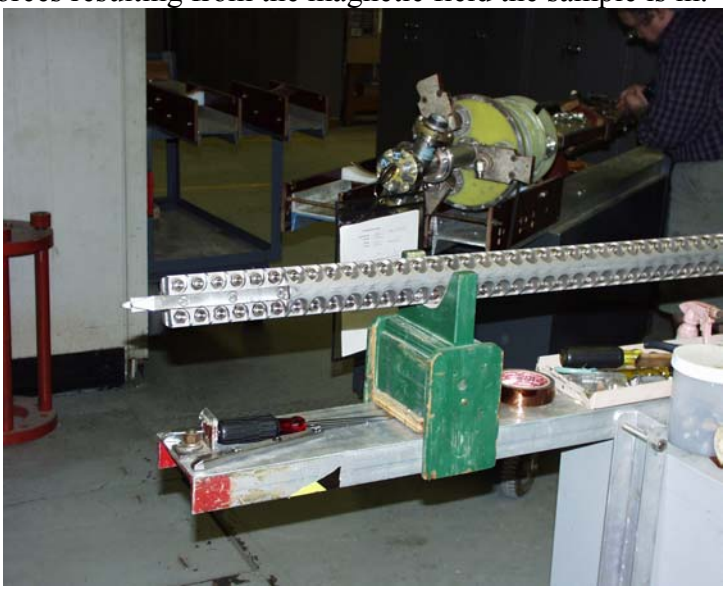

Figure 2 Short sample clamping fixture

Figure 3 Short sample fixture with tophat

Vacuum impregnation

Both HTS and Niobium Tin superconductors are used in an epoxy impregnated coil design. To provide the same environment for the short sample testing, a vacuum impregnation fixture was designed. The fixture is a vacuum bag style assembly, relying on a flexible membrane to provide containment forces against the sample, while allowing easy assembly and disassembly.

Once the sample assembly with voltage taps and spot heaters is made, it is loaded into the impregnation assembly. Figures 4 to 6 detail the simple assembly steps required.

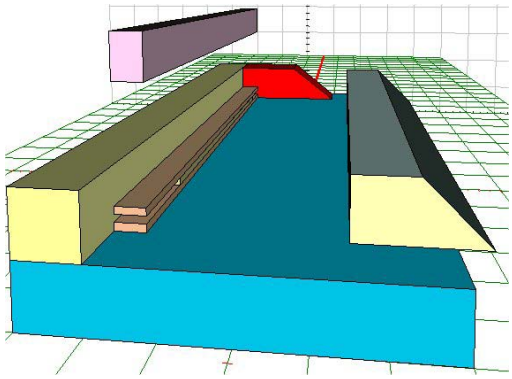

Figure 4 Sample loaded

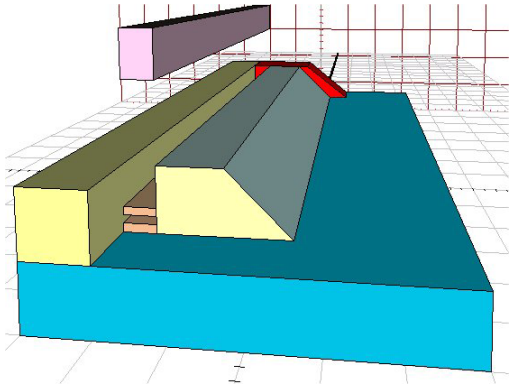

Figure 5 pusher bar installed

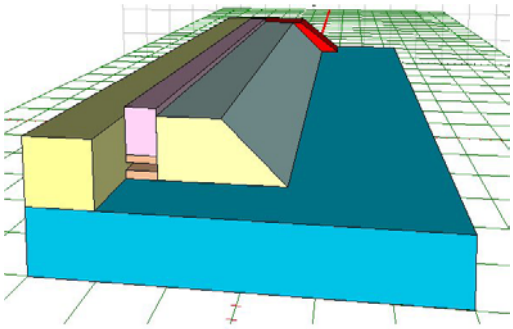

Figure 6 top press plate in place

Once the fixture is loaded, the vacuum bag membrane is secured over the top surface. For easy adjustment of sample width, one edge of the membrane is secured using an aluminum bar and multiple clamps. For different sample widths, the pusher bar will simply slide up against the sample, while a new top press plate is required for different cable widths. As an alternative, g-10 side shims can be used for smaller width cables, filling the void resulting from the gap caused by the press plate overhang.

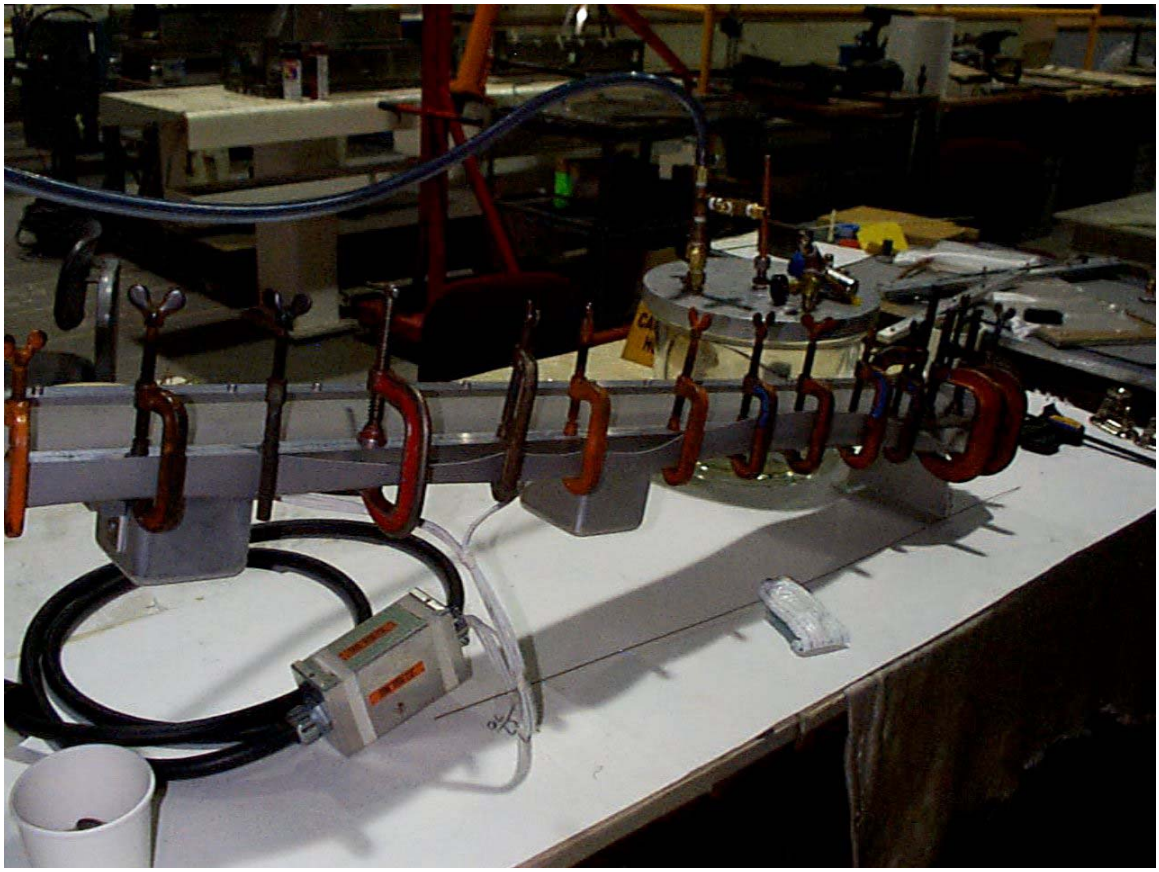

Figure 7 Short sample impregnation setup

Not visible are the heaters on the bottom surface of the fixture. A total of 1500 watts heater power is used to raise the part temperature to 125 C for post cure. The fixture is inclined to allow bubbles formed during curing to rise out of the fixture. The impregnation temperature is 60 C, lowering the epoxy viscosity for the fill. The curing temperature is 110 C for five hours, followed by a 16 hour post at 125 C. For the 5 hour cure, the pressure within the fixture is maintained at 600 torr. This allows the membrane to be forced against the parts during cure, keeping the parts secured.

Figure 8 Finished sample showing voltage tap wires